

: CT (Dynamic perfusion CT) (Source image)
(CBV, CBF, MTT)

PC IDL (Interactive Data Language) CT
PC

: PC CBV, MTT, CBF

: PC
가 가 (prognostic map)

가 (6). (penumbra)
MR CT 가 , Wintermark (7) CTP
(1). CT (CT perfusion; CTP) (prognostic map)
1894 Stewart "Indicator - dilution technique" 가
(2) 1980 Axel CT CTP
(3, 4). CT CBV, MTT, CBF
가 가 가
가 (4-6 mL/s)
CT
CBV (Cerebral Blood Volume), MTT (Mean Transit Time) CBF (Cerebral Blood Flow) (map) MDCT (Multidetector Computed Tomography) 가 (single detector) CT
(5). CTP MR

가 CT

MDCT
CTP

¹
²

CT
 (Prognostic map)
 IDL (Interactive Data Language)
 (Personal Computer; PC)
 PC Pentium IV (Intel, Santa Clara, CA, U.S.A.) 1.5 GHz Microprocessor, 512 MB RAM (Random Access Memory), Video Graphic Array (G450 Dual Head, Matrox Electronic Systems Ltd., Quebec, Canada), 32 MB Video RAM, IDE (Integrated Drive Electronics) 40 GB Hard Disk Drive (5400 rpm) 2000 (Microsoft Corp., Seattle, WA, U.S.A.) IDL (Interactive Data Language, Research Systems Inc., Denver, CO, U.S.A.)

PC
 ROI (Region Of Interest)
 ROI
 fitting
 (Arterial Input Function; AIF)
 fitting ROI
 CBV MTT
 (Central Volume Theory) CBF

CT protocol
 CT (Dynamic perfusion CT data)
 Four channel MDCT (Light Speed, GE medical system, Milwaukee, Wis., U.S.A.) CT
 80 kVp, 250 mAs, 5 mm,
 , 512 x 512 matrix
 (Ultravist 300, Shering AG, Germany) (Medrad, U.S.A.)
 5 mL/sec 50 mL
 5 , 5 mm
 1 1 50
 2004 10 2004 12
 CTP
 10 60.5
 48 80 2
 8
 PC

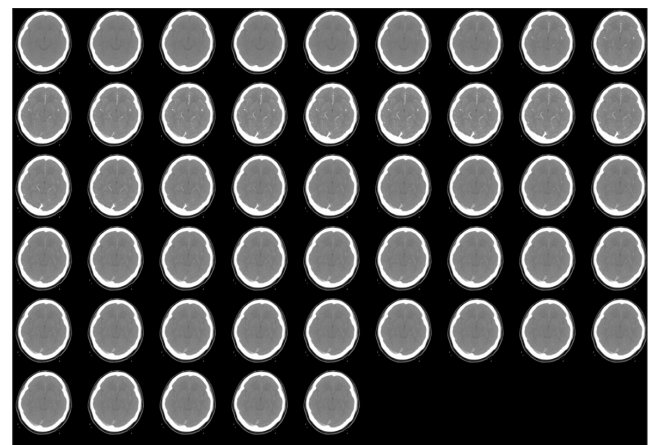


Fig. 1. Source image. Source image set consists of 50 serial dynamic images.

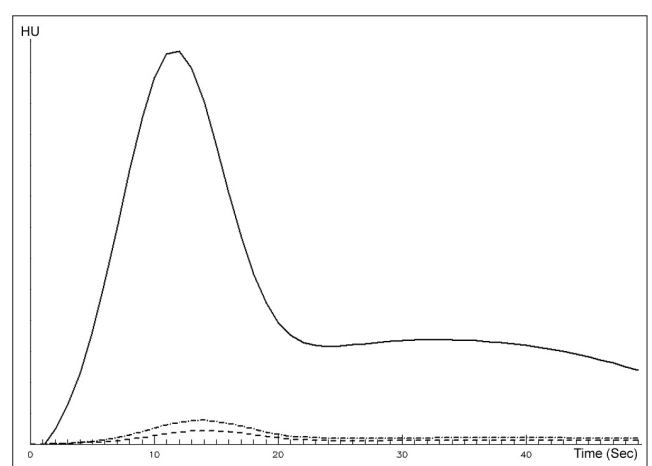


Fig. 2. An example of AIF (Arterial input function) selection and Time-Concentration Curve. An arterial input function (Solid line) is selected by placing a circular region of interest within most densely enhancing artery. Time-concentration curves of gray matter (Dot-solid line) and white matter (Dash line) regions were obtained after injection of contrast media. Abbreviation: HU, Hounsfield Unit

CT
 PiView (Infinit Co. Ltd., Seoul, Korea) PC
 IDL
 가 PC
 (Array) (Fig. 1).

pixel) ROI deconvolution (pixel - by - ± 1.13 ml/100 g, MTT 4.42 ± 0.23 sec, CBF 19.90 ± 3.14 ml/100 g/min (Table 1).
 CTP CBV, MTT, CBF (Fig. 3).
 TIFF (Tagged Image File Format)

CBF, CBV, MTT
 CT, MR, Xenon - CT, PET X - 1972 Ambrose
 (Positron Emission Tomography) Hounsfield CT (Computed Tomography)가
 (8 - 11) MDCT 가 (Image
 postprocessing) CT 가 , (1).
 PC PC
 CBV
 3.13 ± 0.37 ml/100 g, MTT 2.81 ± 0.54 sec, CBF 67.17 ± 4.84 ml/100 g/min , CBV 1.46 Language) . IDL IDL (Interactive Data

Table 1. Comparison of Measured and Published CBV, MTT, and CBF Values

		This study	Ito et al Ref. 8	Hamberg et al Ref. 9	Vonken et al Ref. 10	Wintermark et al Ref. 11
CBV*	GM	3.13 ± 0.37	2.8 ± 0.3	4.3 ± 0.6	6.78 ± 0.99	
	WM	1.46 ± 1.13	1.5 ± 0.2	3.1 ± 0.4	3.78 ± 0.96	
MTT [†]	GM	2.81 ± 0.54	3.2 ± 0.5		6.4 ± 1.8	
	WM	4.42 ± 0.23	4.9 ± 1.9		6.9 ± 2.3	
CBF [‡]	GM	67.17 ± 4.84	56.6 ± 12.8	100.8 ± 23.4	68.7 ± 21.2	71 ± 15
	WM	19.90 ± 3.14	19.8 ± 4.2	72.7 ± 15.3	35.8 ± 12.7	28 ± 10

CBV: Cerebral blood volume, MTT: Mean transit time, CBF: Cerebral blood flow, GM: Gray matter, WM: White matter, Ref: Reference
 * Values are ml/100g, [†]Values are sec, [‡]Values are ml/100 g/min

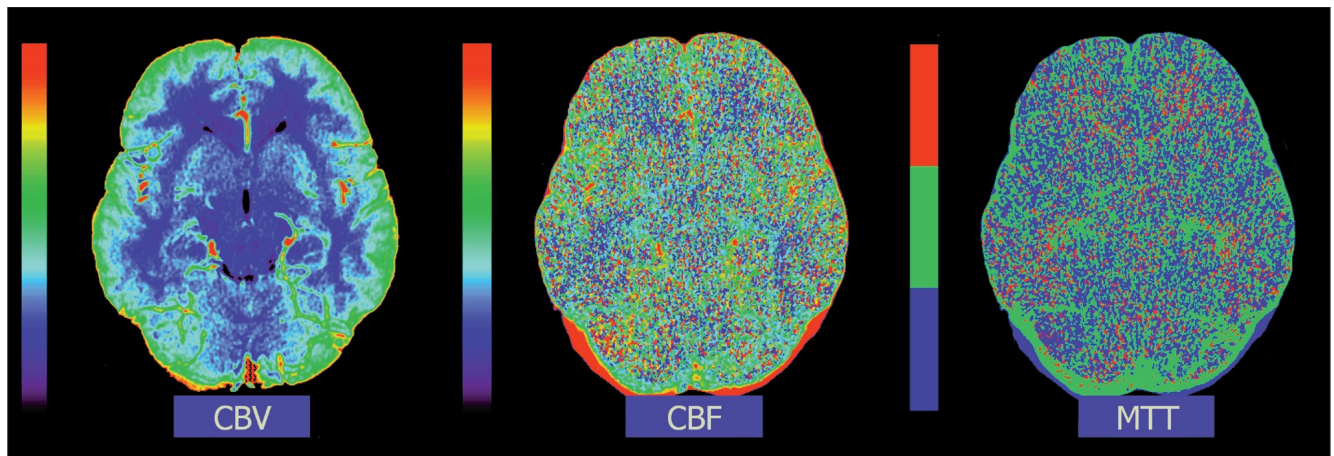


Fig. 3. Perfusion maps. This software reformats first-pass perfusion maps - CBV (Cerebral Blood Volume), MTT (Mean Transit Time), and CBF (Cerebral Blood Flow) maps.

: CT PC
 deconvolution 가 가
 , DICOM TIFF 가 , CTP
 ROI 가 ROI ,
 가 ROI (15),
 ROI (operator dependent)
 PC (Image postprocess- ROI
 ing) PC CT .
 PiView (Infinit Co. Ltd., Seoul, Korea) (16),
 CT , DICOM (Digital Imaging 가 .
 and Communications in Medicine) TIFF (Tagged Image CT, MR, Xenon
 File Format) 가 (Source (8 - 11)
 image) 가 CT , CT
 CT . DICOM CBV MTT 가 ,
 가 PC 가
 , DICOM CT (8 - 10) MTT CBV
 (source image) CT 가
 CT (temporal resolu- fitting deconvo-
 tion), 가 , lution , 가 가
 가 , MDCT
 1 - 2 가 1 - 2 가
 (dynamic image) (source image) 가
 , 1 (single detector) CT CT
 (12). DICOM TIFF
 5 1 1 , PC
 (bolus injection) 가 가
 Xenon (¹³³Xe) CT CTP (Microsoft Windows 9X, Windows
 , 2000, Windows NT, Windows XP) PC
 CBF PC ,
 (11),
 13).
 4 - 5 ml/sec가 (Prognostic map)
 (12, 14), Wintermark , Wintermark (7) CBF 34%
 deconvolution 가 CBV 2.5 ml/100 g
 가 (penumbra)
 가 (14).
 가 ,

PC
가
CT
가

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Development of PC-based Software to Analyze Dynamic Cerebral Perfusion CT Quantitatively and to Reformat Perfusion Maps¹

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Purpose: The purpose of this study was to develop PC-based perfusion software using Microsoft Windows. This software was developed to reformat perfusion maps including CBV (Cerebral Blood Volume), MTT (Mean Transit Time), and CBF (Cerebral Blood Flow) maps and to analyze perfusion quantitatively.

Materials and Methods: Windows-based perfusion software was developed using IDL (Interactive Data Language) as the development tool. The perfusion software was written to load the source image from dynamic first-pass cerebral perfusion CT and to reformat perfusion maps. Mean perfusion values in gray matter and white matter were calculated and compared to previously calculated data reported in literature.

Results: This software reformatted first pass perfusion maps in a user-friendly PC and calculated CBV, MTT, and CBF values. The values were within the normal range of the mean values when compared to previous studies.

Conclusion: CT perfusion maps and perfusion values can be obtained by using the newly developed PC-based perfusion software. Further study is needed to achieve more precise values. However, we believe that in the future, this program may be used in various clinical settings.

Index words : Computers
Brain, CT
Brain, perfusion
Blood, flow

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